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(54) **STATOR AND PROTECTING MEMBER FOR STATOR**

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(\*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 170 days.

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**H02K 3/32** (2006.01)

**H02K 3/52** (2006.01)

(52) **U.S. Cl.**

CPC ..... **H02K 3/345** (2013.01); **H02K 3/325** (2013.01); **H02K 3/522** (2013.01)

(58) **Field of Classification Search**

CPC ..... H02K 3/34; H02K 3/345; H02K 3/325

USPC ..... 310/214, 215

See application file for complete search history.

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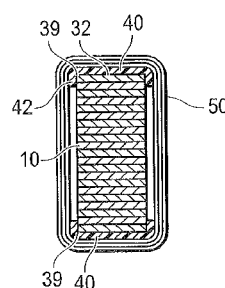
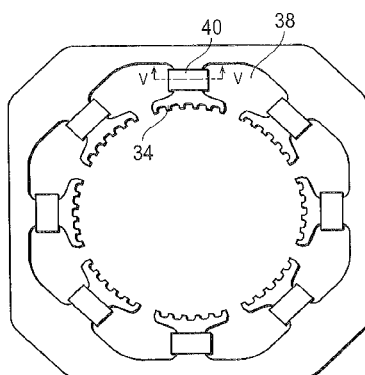
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#### ABSTRACT

There is provided a stator that can suppress degradation in insulating performance and electrical strength performance, shorten a work time, and improve winding efficiency and heat radiation. The stator **1** includes a yoke part **20** formed to be annular, a plurality of tooth parts **30** protruding from the yoke part **20** in an inward direction perpendicular to an axial direction O of a rotor when the rotor is arranged in the yoke part **20**, and protecting members **40** each of which is attached to both end surfaces of the tooth part **30** in the axial direction O to protect a corner of the tooth part **30**. The protecting members **40** have a length in a slot **38** between the tooth parts **30** shorter than a half of an entire length of the tooth part **30** in the axial direction.

**8 Claims, 4 Drawing Sheets**



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FIG.1

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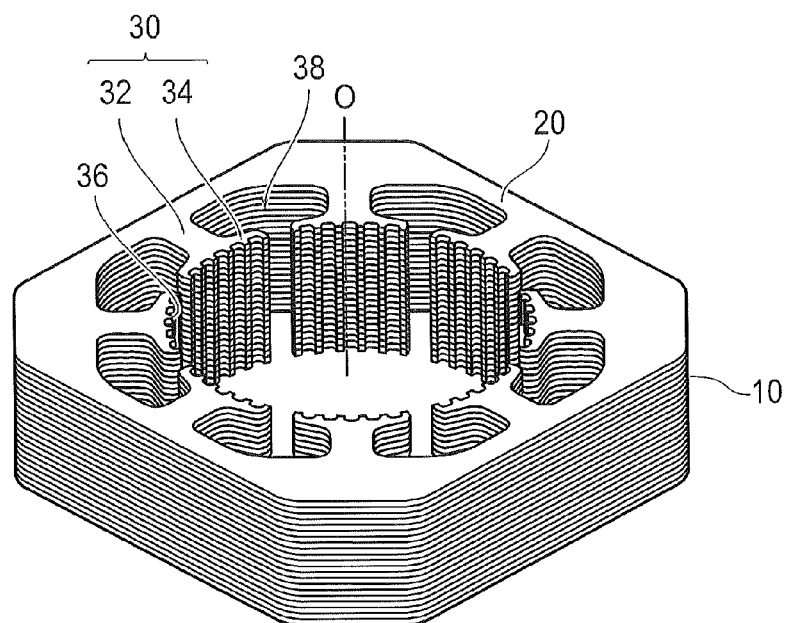


FIG.2

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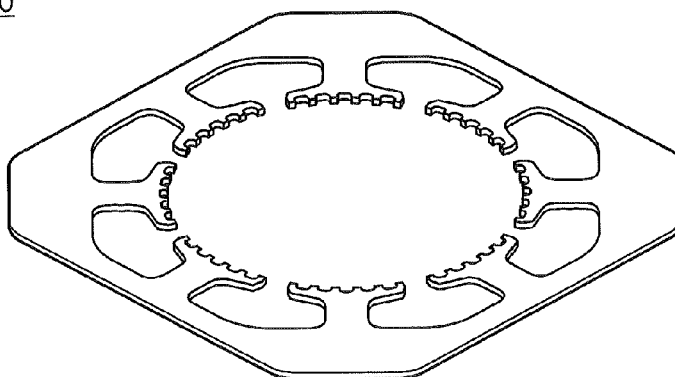


FIG.3

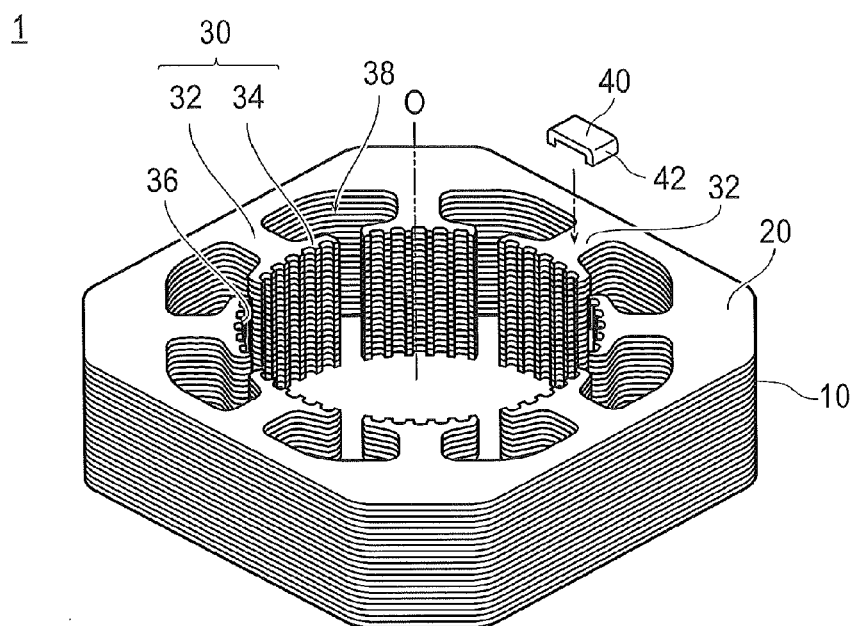


FIG.4

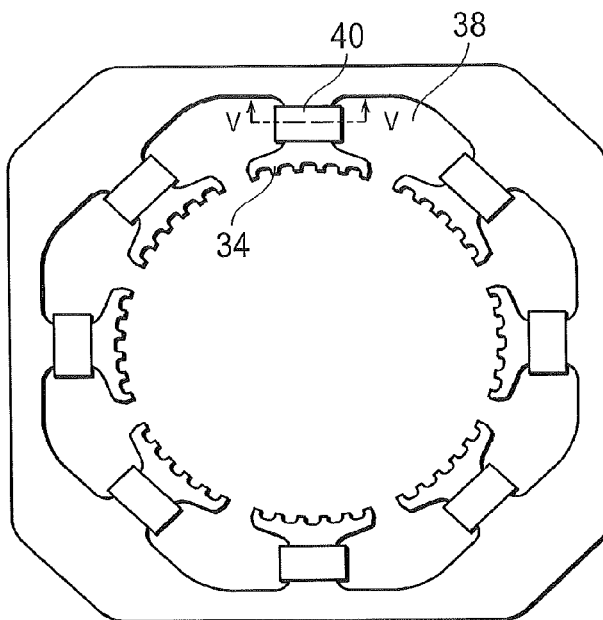


FIG.5

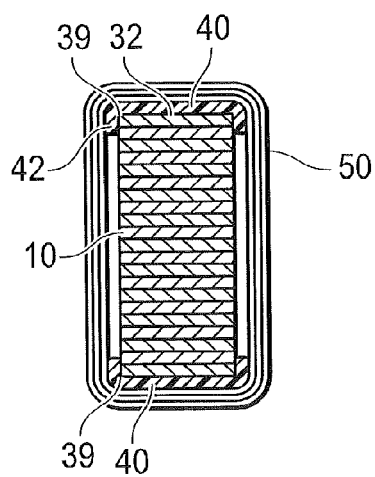


FIG.6

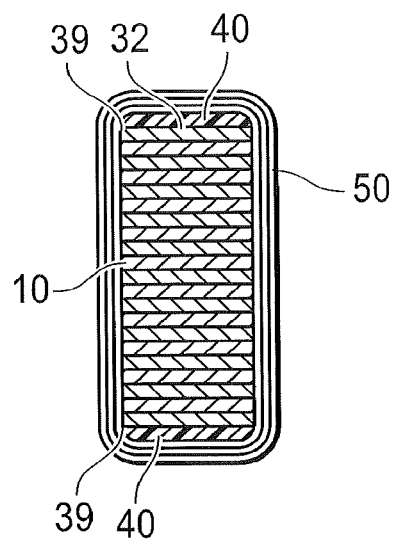
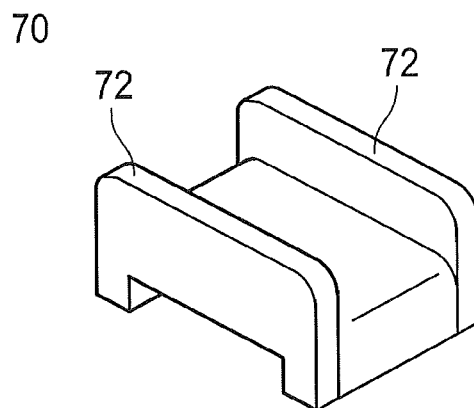


FIG.7



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## STATOR AND PROTECTING MEMBER FOR STATOR

### CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims benefit, under 35 U.S.C. § 119(e), to Japanese Application No. 2011-278701, filed Dec. 20, 2011, the entirety of which is incorporated herein by reference.

### BACKGROUND

#### 1. Technical Field

The present invention relates to a stator that is provided in an electric motor, and relates to a protecting member for a stator.

#### 2. Description of Related Art

A stator provided in an electric motor is usually formed by stacking a plurality of steel plates, and includes teeth for winding an electric wire. Between the electric wire and the stator, insulation needs to be maintained. For this purpose, in some cases, an exposing part of the stator is coated with an insulating material, and the electric wire is coated with an insulating material to secure an insulation property. The electric wire is wound around the teeth of the stator coated with the insulating material.

When the electric wire is wound, the electric wire is pressed into edge portions of the teeth of the stator, and this results in degrading insulating performance and reducing electrical strength. In light of it, a thickness of the insulating coat formed on the stator is required to be large. As a result, a slot where the electric wire wound around the stator is accommodated is made small (wire-winding space is made small) to reduce the efficiency of the wound wire.

In view of it, a stator described in Japanese Patent Application Laid-Open Publication No. 2010-279241 is coated with a resinous insulating member at the portion contacting with an electric wire such that the electric wire does not contact directly with the stator.

However, according to Japanese Patent Application Laid-Open Publication No. 2010-279241, the insulating member is molded in conformity with the shapes of the tooth part and the slot, and the resinous member is inserted into the slot of the stator so as to cover the portion where the electric wire is wound. This technique requires a process of inserting the insulating member, and the work takes time. Furthermore, the insulating member protects the stator over the entire length of the slot in the direction of stacking steel plates, so that when the number of the stacking steel plates is changed, the shape of the insulating member also needs to be changed. This increases a cost of the insulating member. In addition, the insulating member is provided in the slot, so that the region where the electric wire is wound is limited to be narrow. As a result, a winding efficiency is reduced. Furthermore, the insulating member is provided between the stator and the electric wire, so that it becomes difficult for the heat to transmit to the stator from the electric wire that generates heat due to an electric current flowing therethrough. As a result, heat radiation performance is degraded.

### SUMMARY

The present invention has been made in order to solve the problems existing in the above-described background. It is an object of the present invention to provide a stator and a protecting member for a stator, being able to suppress degrada-

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tion in insulating performance and electrical strength performance, to shorten a work time and to improve winding efficiency and heat radiation.

A stator to attain the above-described object includes a yoke part, a plurality of tooth parts, and a protecting member. The yoke part is formed to be annular. A plurality of the tooth parts protrude from the yoke part in an inward direction perpendicular to an axial direction of a rotor (running body) when the rotor is arranged in the yoke part. The protecting member is attached to both end surfaces of one of the tooth parts in the axial direction to protect a corner of one of the tooth parts. The protecting member has a length in a slot between the tooth parts, shorter than a half of an entire length of the tooth parts in the axial direction.

A protecting member for a stator is attached to the stator including a yoke part formed to be annular, and including a plurality of tooth parts protruding from the yoke part in an inward direction perpendicular to an axial direction of a rotor when the rotor is arranged in the yoke part. The protecting member is attached to both end surfaces of one of the tooth parts in the axial direction to protect a corner of one of the tooth parts, the protecting member having a length in a slot between the tooth parts, shorter than a half of an entire length of the tooth parts in the axial direction.

The objects, features, and characteristics of this invention other than those set forth above will become apparent from the description given herein below with reference to preferred embodiments illustrated in the accompanying drawings.

### BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view illustrating a stator according to the present embodiment.

FIG. 2 is a perspective view illustrating a steel plate constituting the stator.

FIG. 3 illustrates a protecting member that is being attached to the stator.

FIG. 4 is a plan view of the stator to which the protecting member for the stator has been attached.

FIG. 5 is a sectional view along the V-V line in FIG. 4 in the state where an electric wire has been wound around the stator.

FIG. 6 illustrates a modified example of the protecting member for the stator.

FIG. 7 illustrates another modified example of the protecting member for the stator.

### DETAILED DESCRIPTION

In the following, embodiments of the present invention will be described with reference to the drawings.

FIG. 1 is a perspective view illustrating a stator according to the present embodiment, and FIG. 2 is a perspective view illustrating a steel plate constituting the stator.

As illustrated in FIG. 1, the stator 1 according to the present embodiment is formed by stacking a plurality of steel plates 10, and fixing the steel plates to one another by means of an adhesive, caulking or the like. The stator 1 includes a yoke part 10 and a tooth part 30, and the entire of the stator 1 is coated with a resin. The yoke 20 is formed to have an annular shape so that a rotor (not illustrated) can be arranged in the inside of the yoke 20. The tooth part 30 protrudes inwards from the yoke part 20 along the direction perpendicular to the axial direction O of the rotor in the state where the rotor has been arranged in the yoke 20. In the present specification, a radial inward direction of the annular yoke part 20 is referred to as “inward direction”, a radial outward direction of the yoke part 20 is referred to as “outward direction,” a direction

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in which the yoke part **20** annularly extends (direction in which a plurality of tooth parts **30** are arranged) is referred to as “circumferential direction,” and a direction (the direction of the rotational axis O of the electric motor) in which the steel plates **10** are stacked is referred to as “stacking direction.”

The tooth part **30** is a part around which an electric wire is wound. A plurality of the tooth parts **30** are arranged in the circumferential direction. The tooth part **30** includes a tooth winding portion **32** around which the electric wire is actually wound, and a tooth end portion **34** formed on the inward side of the tooth winding portion **32**. The tooth end portion **34** is formed so as to extend, from the tooth winding portion **32**, in the both direction toward the neighboring other tooth parts **30**. On the inward side of the tooth end portion **34**, there is formed an arc-shaped gap surface **36** that faces the rotor (not illustrated) when the electric motor is configured. Between the tooth winding portions **32**, there is formed a slot **38** accommodating the wound electric wire.

FIG. **3** illustrates a manner of attaching, to the stator, a protecting member for the stator, FIG. **4** is a plan view of the stator to which the protecting member for the stator has been attached, and FIG. **5** is a sectional view along the V-V line in FIG. **4** in the state where an electric wire has been wound around the stator.

According to the present embodiment, as illustrated in FIG. **3**, the tooth part **30** of the stator **1** has both end surfaces in the stacking direction to each of which the protecting member **40** for the stator is attached. The protecting member **40** for the stator is formed of an insulating material such as a resin, and is attached to the tooth part **30** by means of an adhesive. As illustrated in FIG. **4**, the protecting members **40** for the stator are attached to the all tooth parts **30**, and cover corners **39** (refer to FIG. **5**) of the tooth winding portions **32** of the tooth parts **30**. The protecting member **40** for the stator is formed to have U-shape and bridges the both slots adjacent to the tooth part **30**. The end portions **42** of the protecting member **40** for the stator are inserted and located in the slots **38** respectively. The end portions **42** to be inserted are shorter than a half of the entire length of the slot **38** in the stacking direction, i.e., are shorter than a half of the entire length of the tooth part **30** in the stacking direction. As illustrated in FIG. **5**, the end portions **42** do not cover the entire length of the tooth part **30** even when considering another protecting member **40** for the stator that is positioned on the opposite side of the tooth part **30** in the stacking direction.

As described above, according to the present embodiment, the protecting member **40** for the stator is attached to the tooth part **30**. The protecting member **40** for the stator protects the corner **39** of the tooth part **30**, and instead, the protecting member **40** exposes the curved surface that is smooth in the winding direction of the electric wire **50** is wound. Accordingly, when the electric wire **50** is wound around the tooth part **30** via the protecting member **40** for the stator, the electric wire **50** is not pushed into the corner of the tooth part **30**, so that the electric wire **50** is prevented from being broken. Accordingly, the degradation in the insulating performance and the electrical strength performance can be suppressed.

The protecting member **40** for the stator is formed to have a length in the slot **38** that is shorter than a half of the length of the tooth part **30**. Accordingly, when the protecting member **40** for the stator is attached to each of the both end surfaces of the tooth part **30**, it is unnecessary to insert the end portion **42** to the deep position in the slot **38**. For this reason, the work efficiency is improved, and a work time can be shortened.

Furthermore, the protecting member **40** for the stator protects the corner of the tooth part **30**. While the stator **1** is

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coated with resin, the resin coat can be made thin since the insulating performance at the corner **39** does not need to be taken into consideration. For example, when there is no protecting member **40** for the stator, the resin coat having a thickness of 100  $\mu\text{m}$  is necessary. Meanwhile, the protecting member **40** for the stator can enhance the insulating performance at the corner **39**, so that a thickness of the resin coat may be 10  $\mu\text{m}$ . In accordance with a degree that the resin coat is made thinner, the slot **38** becomes wider, so that the electric wire **50** can be made thicker, or the number of times the electric wire **50** is wound can be increased. Thereby, the winding efficiency can be improved. When the thickness and the number of times the electric wire **50** is wound is not changed, a volume of the electric wire **50** occupying in the slot **38** is smaller to make an air more easily flow in the slot. Thereby, the heat radiation efficiency can be improved.

Furthermore, the protecting member **40** for the stator just covers the end surface regardless of the number of the stacked steel plates **10**. Accordingly, even when a shape of the stator **1** is changed in the stacking direction, a shape of the protecting member **40** does not need to be changed. It is unnecessary to prepare various protecting members **40** for the stator **1** in conformity with the stator **1**, so that the cost can be reduced.

#### MODIFIED EXAMPLE 1

In the above-described embodiment, an example of providing the U-shaped protecting member **40** for the stator is described. However, the present invention is not limited to this.

FIG. **6** illustrates a modified example of the protecting member for the stator.

As illustrated in FIG. **6**, the protecting member **60** including the end portions that are not inserted in the slot **38** (refer to FIG. **4**) at all may be provided. According to such a configuration, the protecting member **60** for the stator does not enter the slot, so that a length of the protecting member **60** for the stator is zero in the area of the slot, and is shorter than the entire length of the tooth part **30**.

As illustrated in FIG. **6**, a width of the protecting member **60** for the stator is equal to a width of the tooth part **30**, so that there are no spaces on the both sides of the tooth part **30**, compared with FIG. **5**. Accordingly, the space of the slot **38** can be more effectively used than in the embodiment of FIG. **5** to improve the winding efficiency, and the heat radiation efficiency.

#### MODIFIED EXAMPLE 2

In a modified example 2, wall portions **72** are provided at the inner position in the inward direction of the protecting member **70** for the stator and at the outer position in the outward direction thereof. The wall portions **72** extend from the protecting member **70** for the stator toward the outer side in the stacking direction.

FIG. **7** illustrates another modified example 2 of the protecting member for the stator.

As illustrated in FIG. **7**, the protecting member **70** for the stator includes the wall portions **72**. Providing the wall portions **72** prevents apart of the wound electric wire **50** from being displaced in the inward direction or in the outward direction of the tooth part **30** when the electric wire **50** is wound around the tooth part **30**.

The present invention is not limited to the above-described embodiments, and may be modified variously within the scope of the claims.



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The entire disclosure of Japanese Patent Application No. 2011-278701 filed on Dec. 20, 2011 including specification, claims, drawings and summary are incorporated herein by reference in its entirety.

What is claimed is:

1. A stator comprising:

a yoke part formed to be annular;

a plurality of tooth parts protruding from the yoke part in an inward direction perpendicular to an axial direction of a rotor when the rotor is arranged in the yoke part, each tooth part include a tooth winding portion configured to be wound with electric wire, and a tooth end portion extending in the inward direction and being wider than the tooth winding portion; and

a protecting member attached to both end surfaces of the tooth winding portion of at least one of the tooth parts in the axial direction to protect a corner of the tooth winding portion of the at least one of the tooth parts, the protecting member having a length in a slot between the tooth parts, shorter than a half of an entire length of the tooth parts in the axial direction, the protecting member being mounted on and protecting the tooth winding portion without covering the tooth end portion and the yoke part.

2. The stator according to claim 1, wherein the protecting member is located only on an outer side of the tooth parts in the axial direction.

3. The stator according to claim 1, wherein the protecting member comprises a plurality of protecting members, each mounted only on a corresponding tooth winding portion, and is formed to have U-shape bridging both slots adjacent to the

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tooth part, and end portions of the protecting member are located in the slots respectively.

4. The stator according to claim 3, wherein the protecting member has a wall portion preventing a part of the wound electric wire from being displaced in the inward direction or in the outward direction of the at least one of the tooth parts when the electric wire is wound around the at least one of the tooth parts.

5. The stator according to claim 4, wherein the wall portion is placed on the tooth winding portion.

6. The stator according to claim 1, wherein the yoke part and the tooth parts are formed by stacking a plurality of steel plates.

7. A protecting member for a stator, being attached to the stator including a yoke part formed to be annular, and including a plurality of tooth parts protruding from the yoke part in an inward direction perpendicular to an axial direction of a rotor when the rotor is arranged in the yoke part,

the protecting member comprises a plurality of protecting members, each being mounted only on a corresponding tooth winding portion at both end surfaces of one of the tooth parts in the axial direction to protect a corner of one of the tooth parts, the protecting member having a length in a slot between the tooth parts, shorter than a half of an entire length of the tooth parts in the axial direction;

wherein the protecting member does not cover the yoke part and does not cover an inward end of any tooth parts.

8. The protecting member for a stator according to claim 7, wherein the protecting member is formed to have U-shape bridging both slots adjacent to the tooth part, and end portions of the protecting member are located in the slots respectively.

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